glass by a feeble electrical discharge; as well as two permanent marks, noticed by Ettrick, which betray a disintegration of the surface.

I have found that when a stronger discharge is employed more complex phenomena of a similar kind are produced. A six-inch Wimshurst machine is arranged with extra condensers, as if to pierce a piece of glass. If this is about four inches square the spark will generally go round it. For a day, more or less, there is only a bleared watery track, $\frac{3}{10}$ inch wide, when the glass is breathed upon; but after this time others develop themselves within the first, a fine central black line with two white and two black on either side, the total breadth being the original $\frac{3}{10}$ inch. These breath-lines do not precisely coincide in position with the permanent scars, but the central one is almost the same as a permanent mark, which the microscope shows to be the surface of glass fractured into small squares of considerable regularity: on either side is a grey-blue line always visible, which Riess ascribes to the separation of the potash. After several months I found two blue lines on either side, which I believe were not visible at first. Of course these blue lines may be seen on most Leyden jars, where they have discharged themselves across the glass.

In 1842 Möser, of Königsberg, produced figures on polished surfaces by placing bodies with unequal surfaces near to them; the action was ascribed to the power of light, and his results were compared with those of Daguerre. Möser says, "We cannot therefore doubt that light acts uniformly on all bodies, and that, moreover, all bodies will depict themselves on others, and it only depends on extraneous circumstances whether or not the images become visible." In general, the multitude of images would make confusion; it can only be freshly polished surfaces that are free to reveal single definite impressions. However great Möser's assumption may be, there are many achievements of modern photography that would be as surprising if they were not so familiar. I have not the means of knowing the precise form of Möser's methods: in the experiments which follow there is usually contact and light pressure, and if they are not wholly analogous, they may for that cause help to generalize the idea: in none of these is electricity applied.

A piece of mica is freshly split, and a coin lightly pressed for thirty seconds on the new surface: a breath-image of the coin is left behind. At the same time it may be noticed that the breath causes abundant iridescence over the surface, whilst it is in a fresh state. It is not clear how the electricity of cleavage can have an active agency in the result.

It is familiar to most people that a coin resting for a while on glass will give an outline of the disk, and sometimes faint traces of the inner detail when breathed upon.

An examination-paper, printed on one side, is put between two plates of glass and left for ten hours, either in the dark or the daylight: a small weight will keep the paper in continuous contact, but this is not necessary if thick glass is used. A perfect breath-impression of the print is made, not only on the glass which lay against the print, but also on that which faced the blank side of the paper. Of course the latter reads directly, and the former inversely; the print was about one year old, and presumably dry.

More often both impressions are white, sometimes one or other or both are black. At other times the same one may be part white and part black, and they even change while being examined.

During a sharp frost with east winds early in March, 1890, these impressions of all kinds were easy to produce, so as to be quite perfect to the last comma; but in general they are difficult, more especially those from the blank side.

At the best period those from the blank side of the paper were white and very strong; also there were white spots and blotches revealed by the breath. They seemed to correspond with slight variations in the structure of the paper, and suggest an idea that the thickness of the ink or paper makes a minute mechanical indentation on the molecules: the state of these is probably tender and sensitive under certain atmospheric conditions, as happens with steel in times of frost.

The following experiments easily succeed at any time:— Stars and crosses of paper are placed for a few hours beneath a plate of glass: clear white breath-figures of the device will appear. A piece of paper is folded several times each way to form small squares, then spread out and placed under glass: the raised lines of the folds produce white breath-traces, and a letter weight that was above leaves a latent mark of its circular rim.

Some writing is made on paper with ordinary ink and well dried: it will leave a very lasting white breath-image after a few hours' contact. If, with an ivory point, the writing is traced with slight pressure on glass, a black breath-image is made at once. Of course this reads directly, and the white one inversely. It is convenient to look through the glass from the other side for inverse impressions, so as to make them read direct.

Plates of glass lie for a few hours on a table-cover worked with sunflowers in silk: they acquire strong white figures from the silk.

In most cases I have warmed the glass, primarily for the sake of cleansing it from moisture; but I have often gone to a heat beyond what this needs, and think that the sensitiveness has been increased thereby.

It is not easy to imagine what leads to the distinction between black and white, different substances act variously in this respect. I have placed various threads for a few hours under a piece of glass, which lay on them with light pressure: wool gives black, silk white, cotton black, copper white. A twist of tinsel and wool gives a line dotted white and black; after a time these traces show signs of developing into multiple lines as in the spark figures.

Two cases have been reported to me where blinds with embossed letters have left a latent image on the window near which they lay; it was revealed in misty weather, and had not been removed by washing. I have not had a chance to see these for myself, but both my informants were accustomed to scientific observation.

A glass which has lain above a picture for some years, but is kept from contact by the mount, will often show on its inner side an outline of the picture, always visible without breath. It seems to be a dust figure easily removed: possibly heat and light have loosened fine paint particles, and these have been drawn up to the glass by the electricity made in rubbing the outer side to clean it. The picture must have been well framed and sealed from external influences; most commonly dust and damp get in and obscure such a delicate effect.

I am not able to suggest simple causes for these varied effects. I am not inclined to think, except in the case of water-colours, which is hardly part of the enquiry, that there is a definite material deposit or chemical change; one cannot suppose that imperceptible traces of grease, ineradicable as they may be, would produce complete and delicate outlines. The cleaning off of impressions may at first seem to indicate a deposit; but this renewal of the surface might rather be like smoothing out an indented tin-foil surface: such a view might explain the case where a blank over-electrified disk is developed into fine detail. The electrified figures seem to point to a bombardment, which produces a molecular change, the intensity of electricity bringing about quickly what may also be done by slow persistent action of mechanical pressure. At present it seems as if most of the phenomena cannot be drawn out from the unknown region of molecular agency.

While experimenting I was not within reach of references to former researches, but I have since done my best to find them out, and to indicate all I have learnt in the body of my paper.

Poggendorff, vol. lvii. p. 492; translated in *Archives de l'Electricité*, 1842, p. 647.
Riess' "Electrische Hauchfiguren" in "Repertorium der Physik"; translated in *Archives de l'Electricité*, 1842, p. 591.
Reiss' "Die Lehre von der Reibungs Electricität," vol. ii. pp. 221–224.
Mascart, "*Electricité Statique*," vol. ii. p. 177.
Taylor's "Scientific Memoirs," vol. iii.

SCIENTIFIC SERIALS.

American Journal of Science, December.—An experimental comparison of formulæ for total radiation between 15° C. and 110° C., by W. de Conte Stevens. The formulæ given by Dulong and Petit, by Rosetti, Stefan, and Weber, were tested for a comparatively small range of differences by a determination of the heat radiated from an iron disc at a distance of about 30 cm. from a thermopile. The results tended to show that H. F. Weber's formula (*Sitzungsber.*, Berlin, 1888) agrees most closely with experiment. Stefan's formula, according to which the heat emitted in unit of time is proportional to the fourth power of the absolute temperature, is also fairly accurate,

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but Dulong and Petit's values are too high, and Rosetti's too low.—Notes on silver, by M. Carey Lea.—Notes on silver chlorides, by the same. Fused silver chloride poured into petroleum and placed in the sunlight without removing it from the liquid, is instantly darkened. From this it appears that the presence of oxygen or moisture is not essential to the darkening of silver chloride in light. The chlorine may be taken up by some other substance.—A remarkable fauna at the base of the Burlington Limestone in north-eastern Missouri, by Charles Rollin Keyes.—Glacial pot-holes in California, by H. W. Turner.—The lavas of Mount Ingalls, California, by H. W. Turner.—A method for the quantitative separation of barium from strontium by the action of amyl alcohol on the bromides, by Philip E. Browning. The solubility of barium bromide is about 0·0013 grm. on the oxide in 10 cc. of amyl alcohol, while that of strontium bromide is 0·2 grm. To obtain the bromides, the precipitated and thoroughly washed carbonates of Ba and Sr are treated with hydrobromic acid obtained by the action of dilute sulphuric acid on potassium bromide.—Note on the method for the quantitative separation of strontium from calcium by the action of amyl alcohol on the nitrates, by P. E. Browning. Recent work on this method has shown that the total correction amounts to 0·0006 grm. on the strontium oxide, and 0·0010 on the calcium as sulphate.—Study of the formation of the alloys of tin and iron, with descriptions of some new alloys, by W. P. Headden.—Notes on the Cambrian rocks of Pennsylvania and Maryland from the Susquehanna to the Potomac, by C. D. Walcott.—Volcanic rocks of South Mountain in Pennsylvania and Maryland, by G. H. Williams.

Wiedemann's Annalen der Physik und Chemie, No. 11.—On the behaviour of allotropic silver towards the electric current, by A. Oberbeck.—On the indices of refraction of dilute solutions, by W. Hallwachs.—On capillary constants, by M. Cantor.—On the chemistry of the accumulator, by M. Cantor.—On the fall of potential during discharges, by O. Lehmann. A series of important investigations on discharges between electrodes and in tubes without electrodes.—Expansion of water with the temperature, by K. Scheel.—A method for determining the density of saturated vapours and the expansion of liquids at higher temperatures, by B. Galitzine. This method has the advantage of extreme simplicity combined with accuracy. A small glass tube, about 5 cm. long and a few mm. thick, is closed at one end and drawn out into a capillary at the other. After determining the weight and internal volume of the tube, a small quantity of the substance to be investigated is introduced into it in the liquid state. This is made to boil, and then the tube is sealed by fusing. On raising the temperature, the surface of separation between the liquid and its vapour is displaced, until at a certain temperature all the liquid is converted into saturated vapour. The tube is then cooled until the vapour reappears, when the temperature is again taken. This can be repeated several times, thus giving an accurate value for the density of saturated vapour at a certain temperature. The same process can be used to determine the expansion of the liquid. As the temperature rises, the volume of the liquid will in general increase up to a certain point, when the vaporization becomes more pronounced. This maximum, which can be observed more accurately by drawing out the tube near that point, gives a value for the expansion. For the density at that point is a function of the density at 0° C. and the temperature, and the pressure is that of the saturated vapour at the same temperature. Thus it is only necessary to find the volumes of the liquid and the vapour, and the density of the latter from the previous experiment.—On radiant energy, by B. Galitzine.—Note on the electricity of waterfalls, by J. Elster and H. Geitel.—Apparatus for demonstrating the Wheatstone bridge arrangement, by A. Oberbeck.—Determination of the coefficient of self-induction by means of the electro-dynamometer, by O. Troje.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 15.—On some new reptiles from the Elgin Sandstone, by E. T. Newton, communicated by Sir Archibald Geikie, F.R.S.

During the last few years a number of reptilian remains have been obtained from the Elgin Sandstone at Cuttie's Hillock, near Elgin, which are now in the possession of the Elgin Museum and of the Geological Survey. These specimens represent at least eight distinct skeletons, seven of which undoubtedly belong to the Dicynodontia, and one is a singular horned reptile, new to science. All the remains yet found in this quarry are in the condition of hollow moulds, the bones themselves having entirely disappeared. In order, therefore, to render the specimens available for study, it was necessary, in the first place, so to display and preserve these cavities that casts might be taken which would reproduce the form of the original bones. Gutta-percha was found to be the most suitable material for taking these impressions; and in some instances, especially in the case of the skulls, the casts had to be made in several parts and afterwards joined together.

The first specimen described is named *Gordonia Traquairi;* it is the one noticed by Dr. Traquair in 1885, and referred to the Dicynodontia; besides the skull, it includes fragmentary portions of other parts of the skeleton, and is contained in a block of sandstone which has been split open so as to divide the skull almost vertically and longitudinally. The two halves have been so developed that casts made from them exhibit the left side and upper surface, as well as the main parts of the palate and lower jaw. In general appearance this skull resembles those of *Dicynodon* and *Oudenodon*. The nasal openings are double and directed laterally; the orbits are large and look somewhat forwards and upwards. The supra-temporal fossa is large, and bounded above by the prominent parieto-squamosal crest, and below by the wide supra-temporal bar, which extends downwards posteriorly to form the long pedicle for the articulation of the lower jaw. There is no lower temporal bar. The maxilla is directed downwards and forwards to end in a small tusk. Seen from above, the skull is narrow in the inter-orbital and nasal regions, but wide posteriorly across the temporal bars, although the brain-case itself is very narrow. There is a large pineal fossa in the middle of a spindle-shaped area, which area is formed by a pair of parietals posteriorly and a single intercalary bone anteriorly.

The palate is continuous with the base of the skull; the pterygoids on each side send off a distinct process to the quadrate region. Towards the front the mediam part of the united pterygoids arches upwards, and the outer sides descend, forming a deep groove; from the evidence of other specimens it is clear that the palatines, extending inwards, converted this groove into a tube, and thus formed the posterior nares. The ramus of the lower jar is deep, with a large lateral vacuity, and the two rami are completely united at the symphysis. The back of this skull is not seen, but two other specimens, referable to this same genus, show that the occiput had two post-temporal fossæ on each side.

This specimen is distinguished from *Dicynodon* by the presence of two post-temporal fossæ on each side of the occiput, by the small size of the maxillary tusk; and probably by the elongated spindle-shaped area enclosing the pineal fossa, and also by the slight ossification of the vertebral centra.

A second and much smaller specimen, provisionally referred to *G. Traquairi*, has, besides the skull, a fore-limb well preserved. The humerus of this shows the usual Anomodont expansion of its extremities; its large deltoid crest is angular, and set obliquely to the distal end.

Three other species are referred to the same genus, namely:—

Gordonia Huxleyana, which is distinguished from *G. Traquairi* by its proportionately wider and more depressed skull, and by the absence of the concavity between the orbits which is present in the latter species. The humerus has the distal extremity oblique to the deltoid crest, which was probably rounded and not angular.

G. Duffiana has the skull even wider than in *G. Huxleyana*, and the portion of a humerus found with this skeleton has the two extremities set nearly at right angles to each other.

G. Juddiana has an elongated skull resembling that of *G. Traquairi*, but the parietal crests are less developed, the bones of the nasal region are much thickened and overlap the nasal apertures, the small tusk is placed a little further back and points more directly downwards, and the pineal fossa is smaller than in either of the other species.

A second generic form is named *Geikia Elginesis*. This is a skull nearly allied to *Ptychognathus*, Owen, but is distinguished by its shorter muzzle and the entire absence of teeth; the upper part of the skull, between the orbits, is also peculiar, forming a deep valley open anteriorly, with a ridge on each side, the anterio

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